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Crafting effective climate, energy, and environmental policy: time for action

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The evolving landscape of environmental, climate, and energy policy is marked by both pressing global challenges as well as opportunities for transformative action. Here, we discuss emerging debates and explore key themes in this dynamic field. We identify five key research strands that enhance climate change understanding and guide sustainable policymaking: actor dynamics, policy-science-society interface, stakeholder participation, global environmental cooperation, and environmental justice. A central question arises: How can we better reconcile the low-carbon transition with challenges such as climate justice, stakeholder collaboration, and cultural dimensions in policy formulation? We argue that the answer must lie in the application of a more wholesome vision of policymaking processes that focuses on the interconnectedness of these themes and emphasizes the need for integrated solutions, transdisciplinary collaboration, innovation, and inclusive governance to address complex environmental challenges. Our aim here is to deepen our understanding of environmental policy research's complexities and future directions. We make the case for a concerted effort from policymakers, scholars, and stakeholders to navigate toward a more sustainable and equitable future.

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The new imperative in policymaking and the role of social sciences

Humanity has made remarkable strides in the pursuit of sustained global economic growth, enriching the lives of billions (Todaro and Smith, 2020). Yet, this progress has been accompanied by significant costs (Commoner, 2013; Tol, 2018). The environmental toll of increased economic activity manifests, among others, in deforestation, pervasive pollution of our air and water, and, possibly the largest challenge of the Anthropocene, climate change (Masson-Delmotte et al., 2021; Ruv Lemes et al., 2023).

In the 2020s, the term 'multiple crises' has permeated political discussions, referring to the situation where society globally has to cope with not only one but several existential crises at the same time; namely the global Covid pandemic, climate change, and a global food and energy security threat.

Policymakers face an increasingly complex landscape that is characterized by multifaceted interdependencies, geopolitical tensions, and the challenge of harmonizing development-related concerns and economic advancement with environmental stewardship (Klaassen and Opschoor, 1991; UNEP United Nations Environment Programme, 2020; Belaïd, 2022; Belaïd et al., 2023).

With growing awareness of the multiple crises and challenges come new imperatives for formulating and implementing climate, environmental, and energy policies. Such policies should encompass a holistic vision; that means, for instance, addressing not only climate change mitigation but also broader sustainability requirements. They need to be integrative on several levels: horizontally (across different policy resorts, themes, and knowledge forms) and vertically (involving different actors and governmental levels). Moreover, they should be participatory, engaging a wide range of stakeholders.

Social sciences can play a critical role in keeping pace with the quickly evolving dynamics in the world and generating practice-oriented knowledge (e.g., on how effective policy formulation and implementation processes are). They can help increase understanding of how transformations—solutions—might work well. Many of the above-named aspects are tackled under the quickly evolving field of 'global climate and environmental governance'. This field focuses on the intricacies of policymaking and the different elements in shaping environmental outcomes.

From research to action: key research strands to inform energy and climate policies

Climate change presents multifaceted challenges that demand robust environmental governance frameworks. Here, we delve into five key research strands that illuminate climate change understanding and guide sustainable policymaking. Examining actor dynamics, the policy-science-society interface, stakeholder participation, global environmental cooperation, and environmental justice sheds light on crafting effective and equitable climate strategies. These strands not only reveal the inherent complexities of environmental governance but also emphasize the necessity of interdisciplinary and inclusive approaches for fostering just and sustainable transitions.

Actors and agency: actor dynamics in environmental governance. Environmental, climate, and energy policymaking has become a very complex landscape because the number and heterogeneity of actors is vast.

First, a critical focus for academic research is the mapping of these actors and the analysis of their orchestration, coordination, and interactions within the governance process. This involves examining which actors participate, what knowledge they bring into the governance process, and what capacities, resources, and power these actors have to solve the climate, environmental, or energy problems at hand. Two groups of actors that have long been under academic scrutiny yet continue to merit new assessments are Non-Governmental Organizations (NGOs) and private stakeholders. The key question remains: how do governmental decisions impact their actions and vice-versa?

Recent studies provide valuable insights into these dynamics. Bey (2022) explores how environmental NGOs (ENGOs) can effectively influence policy through two main strategies: either by employing a large staff and diverse lobbying tactics across multiple venues or by leveraging a large membership base while using varied lobbying approaches. This research offers new perspectives for ENGO leaders on impacting environmental policy. Complementing this, Du et al. (2024) study focus on the private sector in the Chinese context, demonstrating how government initiatives significantly encourage firms to adopt renewable energy technologies. Their findings show that this effect is primarily achieved through increased R&D investment, government subsidies, and rising energy costs. The impact is most pronounced in biomass and waste energy technologies, private firms, high energy-consuming industries, and coal-dependent cities. Moreover, these government initiatives have long-term and spillover effects, stimulating renewable energy innovation both locally and in neighboring areas.

These studies collectively highlight the complex interplay between non-state actors, government policies, and corporate practices in shaping environmental sustainability efforts. They underscore the importance of understanding various actors' roles, capacities, and interactions in environmental governance, providing a foundation for further research in this critical area. The evolving landscape of environmental policymaking necessitates examining how different actors orchestrate their efforts, coordinate their actions, and interact within the broader governance framework to effectively address pressing climate, environmental, and energy challenges.

Policy-science-society nexus: bridging the gap by integrating social science. Second, a crucial strand of research assesses the relationship between the policy-science (and society) interface in environmental governance. Researchers examine how science is involved in or informs the formulation and implementation process of environmental, climate, and energy policy. Here, in particular, the increasing awareness of not only science on the impacts of climate change but mostly the knowledge on solutions, societal behavior, or how to design a transformation towards society—knowledge generated by the social sciences—is crucial. An example of the growing awareness of this gap is exemplified by the process of the Intergovernmental Panel on Climate Change (IPCC) and the much stronger involvement of social scientific knowledge in its latest report (IPCC, 2023). This development underscores the vital role of interdisciplinary approaches in addressing complex environmental challenges.

Morris et al. (2024) provide a compelling analysis of this trend, examining the integration of social sciences expertise in environmental policy and practice (EPP). Their findings reveal positive changes in the perception, resourcing, and utilization of social sciences within EPP, along with examples of positive impact. However, the study also uncovers persistent barriers to effective integration, mirroring challenges faced in academic multi-disciplinary research, such as late, narrow, or selective enrollment of social scientists.

This research highlights a critical paradox: while EPP organizations increasingly recognize the value of social sciences expertise, practical integration remains challenging. Morris et al.

(2024) identify both common obstacles shared with academic settings and unique challenges specific to policy environments. These findings underscore the need for a more comprehensive and integrated approach to environmental policymaking. They suggest that overcoming these barriers could significantly enhance environmental policies' effectiveness and social acceptability, thereby accelerating progress toward sustainable societal transformations.

Stakeholder participation: harnessing diversity for more nuanced policies. Third, in the past decade, a significant research focus has emerged on the participation of diverse stakeholders in governance. This strand of inquiry examines how engaging a wide range of actors—from public citizens to industrial stakeholders—can not only enhance the policymaking process but also create innovative policy solutions and gain more acceptance at the implementation stage of policies.

Both experimental data as well as theoretical and conceptual debates have enriched this topic significantly, leading to a more nuanced understanding of participatory approaches in environmental policy. Researchers have explored various methods of co-creating solutions with citizens, like reducing emissions in the transport or living sectors and improving the urban environment. (reference).

An interesting recent article by Boso et al. (2024) explores innovative approaches to citizen engagement in air pollution mitigation policies and the polycentric approach in mitigating climate change, demonstrating the potential of bottom-up initiatives in addressing environmental challenges. Specifically, this analysis reveals the powerful impact of role-playing games as a participatory tool. These games serve a dual purpose: (1) promote critical thinking and enhance argumentation skills among the general public, fostering a more informed and engaged citizenry, and (2) provide valuable insights to policymakers, aiding in the design of more operative and equitable action plans.

The findings exemplify a broader trend in environmental policy research, which increasingly recognizes the value of participatory approaches. This shift towards more inclusive policymaking processes represents a promising avenue for addressing complex environmental issues, as it aligns policy objectives more closely with societal needs and values.

Global environmental cooperation: a critical lens on international climate policy. Fourth, a central debate is led about forms of global environmental, climate, and energy cooperation. This field of inquiry addresses crucial questions such as: under which conditions different forms of cooperation, ranging from bilateral treaties to negotiations under the UNFCCC, take place and how they are affected by domestic policymaking and vice-versa. The authors ask what makes cooperation effective and what are challenges and inherent tensions.

A recent study by Stankovic et al. (2023) provides valuable insights into this complex landscape, analyzing the effectiveness of international climate agreements and illuminating the intricate interplay between national interests and global environmental objectives. Their research reveals a nuanced dynamic: while social pressure from state and non-state actors can potentially elevate countries' climate ambitions, it may also produce unintended negative consequences. Specifically, excessive pressure can lead political leaders to make unrealistic commitments, ultimately resulting in noncompliance and eroding trust in global agreements such as the Paris Agreement. This finding underscores the delicate balance required in international climate diplomacy and highlights the need for a more sophisticated understanding of the mechanisms driving global cooperation (Hatipoglu et al., 2023; Gökçe et al., 2024).

The Paris Agreement of 2015 has become a prime case study in this field, as it is, on the one hand, a landmark for climate policy, but on the other hand, almost ten years after its adoption, lacks both, formulation of ambitious (national) targets and implementation of policies. These gaps between aspiration and action have spurred research into novel forms of cooperation, like climate clubs, which seek to address the shortcomings of the Paris Agreement and have emerged as a subject of research (Unger & Thielges, 2021). The emergence of these alternative cooperative mechanisms reflects a broader trend in global environmental governance: the search for more effective, flexible, and responsive approaches to addressing climate change. This shift acknowledges the limitations of traditional multilateral agreements and explores innovative ways to align national interests with global environmental imperatives.

Environmental justice and equity: a critical dimension of climate policy. Fifth, discussions on environmental, climate, and planetary justice have permeated the social sciences. The main themes revolve around the diverging conceptual approaches towards justice, the economic and social ramifications of climate (or environmental and energy) initiatives, and how justice and distributive concerns can be integrated into policymaking and implementation processes. This focus on justice reflects a growing recognition that effective and sustainable environmental policies must address not only ecological concerns but also social and economic inequities (Belaid et al., 2023).

A recent study by Della Valle et al. (2023), assesses climate justice awareness among cities striving for climate neutrality. The study underscores the importance of incorporating justice considerations into urban climate strategies. The results demonstrate a positive correlation between a city's climate engagement and its consideration of social justice, influenced by factors such as geography, governance structures, and governmental support.

Research in this area exemplifies the broader trend in environmental justice research, which increasingly recognizes the interconnectedness of environmental goals and social equity. It highlights the need for a more holistic approach to climate policy that considers not only technical solutions but also their social and economic implications. Looking forward, environmental justice is poised to play a crucial role in shaping climate policy debates.

Future research directions and the way forward

Reflecting on the insights gleaned from scanning the previous and current research directions, it becomes evident that much work remains to be done. As we look ahead, several critical questions emerge as ripe areas for future research, each interconnected and essential for advancing environmental policy:

The role of actors and enhancing cooperation in global climate and energy politics remain a crucial area of inquiry. How can we enhance cooperation in global climate politics, including governance structures for multilateral agreements and implementation mechanisms that improve compliance and effectiveness? How can we strengthen the translation of political intentions into tangible outcomes? Strong and integral governance structures will enhance accountability and ultimately make the implementation of climate agreements at local, national, and international levels more effective. This needs to go hand in hand with stronger ambitions, consistent implementation, and enforcement, but also new alliances that make quicker progress in specific environmental areas or sectors.

The interface between policy, science, and society presents another fertile ground for research. How can we further integrate insights from diverse forms of knowledge to inform more holistic and effective policy responses to environmental challenges? This question speaks to the need for interdisciplinary collaboration, a solid science-policy interface, and inter- and intra-governmental coordination, recognizing that complex environmental issues require multifaceted solutions that draw upon expertise from various fields.

What role can emerging technologies and innovations play in accelerating the transition to a more sustainable and resilient global economy and what can they not deliver? Innovations in technology hold immense potential for driving transformative change in environmental policy and practice. From renewable energy solutions to sustainable agriculture practices, harnessing technological advancements can help expedite the transition toward a more sustainable and resilient global economy. Yet, market readiness is not given for all these technologies, and sustainable progress will require colossal investment as well as suitable policy regulations. Further, innovation and knowledge capacities are unequally distributed globally, and some technologies come with risks for the earth and society that are still insufficiently researched. Also, a debate must be led on the fact that there might not be a "silver bullet technology" for every challenge. Technological solutions will have to go hand in hand with the transformation of existing structures and behavioral changes (Mar et al., 2024). Integrating human dimensions like culture and behavior holds significant potential to advance environmental policy solutions (Belaïd and Flambard, 2023, 2024). We can create more effective and culturally sensitive solutions by understanding and incorporating cultural norms, behaviors, and values into policy design and implementation. However, the crucial question remains: how can we better integrate these dimensions into policymaking processes?

Stakeholder participation emerges as a critical component of effective environmental policymaking. Future research should focus on the intricacies of such engagement to ensure that policies reflect society's diverse needs and perspectives. Empowering communities to participate in decision-making actively can lead to more inclusive and socially responsive environmental policies.

Environmental justice and equity considerations are central to effective policy formulation and implementation. What better strategies can be implemented to ensure that climate, energy, and environmental policies prioritize equity and justice, particularly for marginalized communities? At the heart of these concerns stands the need to address social inequalities and ensure that vulnerable populations are not disproportionately impacted by environmental degradation or policy interventions and that they are able to benefit from the benefits that arrive with measures. These questions underscore the complexity of the environmental policy landscape and highlight the interconnectedness of various policy formulation and implementation dimensions. Addressing these challenges will require holistic approaches prioritizing collaboration, equity, innovation, and participatory decision-making.

Addressing these interconnected questions can transform environmental policy and practice by prioritizing equity, strengthening global cooperation, integrating human dimensions, leveraging technology, and enhancing public engagement. This ensures inclusivity, accountability, effectiveness, and transparency in policymaking. Ultimately, the future of climate and energy policy research lies in its ability to integrate these diverse perspectives.

Data availability

Any data analyzed is included in the article.

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Informed consent

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